High PV penetration in the European context

Challenges – Threats –Opportunities*

*delete as appropriate

Manoël Rekinger

Senior Advisor – Electricity grid and markets

Part

01

State of play

“But the game is out there, and it's either play or get played”
Omar Little – The Wire

PV, a risk for (*fill in as appropriate*)

REUTERS EDITION: UK Register

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ARTICLE

Renewable energy increases blackout risk-report

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Wed Nov 23, 2011 5:33pm GMT

* Europe needs over 28 bln euros to invest into grid

* World investment of $13.6 trl needed

By Ethan Bilby

LONDON, Nov 23 (Reuters) - Growth in the renewable energy sector in the last decade and a lack of incentives for utilities to invest into new power transmission capabilities mean there is an increased risk of blackouts, a report said on Wednesday.

The joint report by German financial and insurance group Allianz and the Chief Risk Officer Forum said the championing of renewables in Europe had come at the price of reliability.

Aging power infrastructure means the European Union (EU) will need to make investments of between 23 billion and 28 billion euros over the next five years, the report said.

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Quotes

Allianz SE
ALVG.DE
€123.53
-0.37 -0.30%
09:01:00 BST

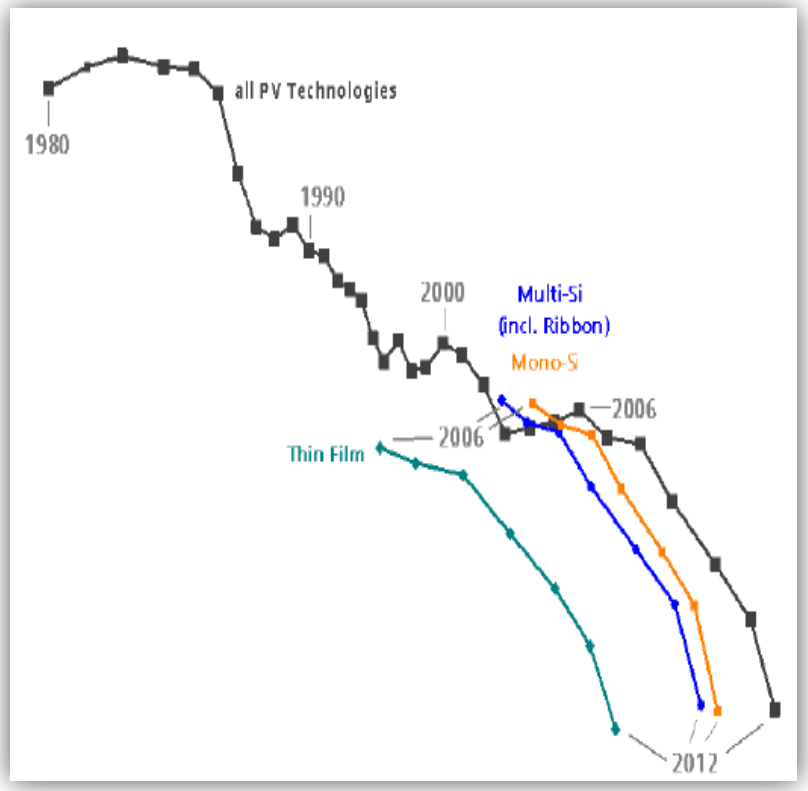
*"**The stability of Europe's electricity generation is at risk from the warped market structure caused by skyrocketing renewable energy subsidies** that have swarmed across the continent over the last decade."*
Forbes

"The mechanisms required to compensate for intermittency can increase the cost of solar and wind energy many-fold, especially at higher penetration levels."
The Energy Collective

*"European industry is increasingly turning to the US to take advantage of cheaper energy (…) **The current European model of promoting renewable energy regardless of the price and burden to public finances puts European economies in a clearly disadvantaged position**."*
OilPrice.com

*"The CEOs of 10 utilities companies,(…) are **calling for an end to subsidies for wind and solar energy, which they say add too much power to a market already struggling with overcapacity**. (…) "European energy policy has run into the wall," GDF Suez CEO Gerard Mestrallet said."*
Euractiv

PV, the game changer ?



***"The companies would have been in trouble anyway, whatever happened to renewables**. During the 2000s, European utilities overinvested in generating capacity from fossil fuels, boosting it by 16% in Europe as a whole (…).The market for electricity did not grow by nearly that amount, even in good times; then the financial crisis hit demand"*

The Economist: "How to lose half a trillion Euros"

"Solar is growing so fast it is going to overtake everything"

"Our markets were made up for a very centralised system, very large plants and plants that were distant from loads. We're moving to a much more distributed system that also has consumers participating as resources with their load."

Jon Wellinghoff, chairman of the US Federal Energy Regulatory Commission (FERC)

"Now, if you're a utility company, you're going to be very worried about that. (…) So I've been telling them there's another business model."

Stephen Chu, former US Energy Secretary(Source: Reneweconomy)

Source: Fraunhofer ISE , 2012

Part

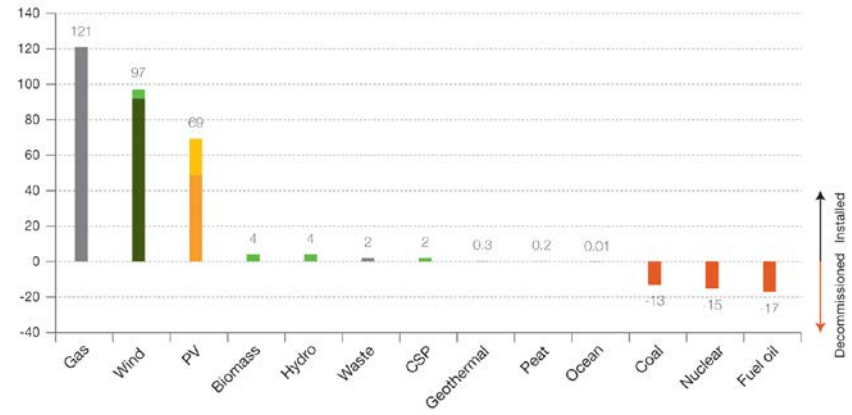
02

Current status and trends

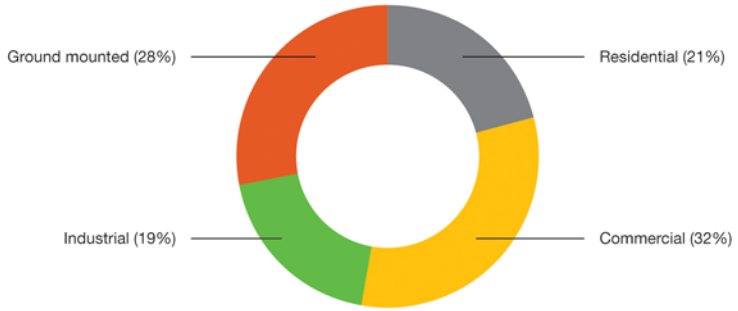
"I think there is a world market for maybe five computers"
Attributed to Thomas Watson – CEO of IBM in 1943

PV in Europe

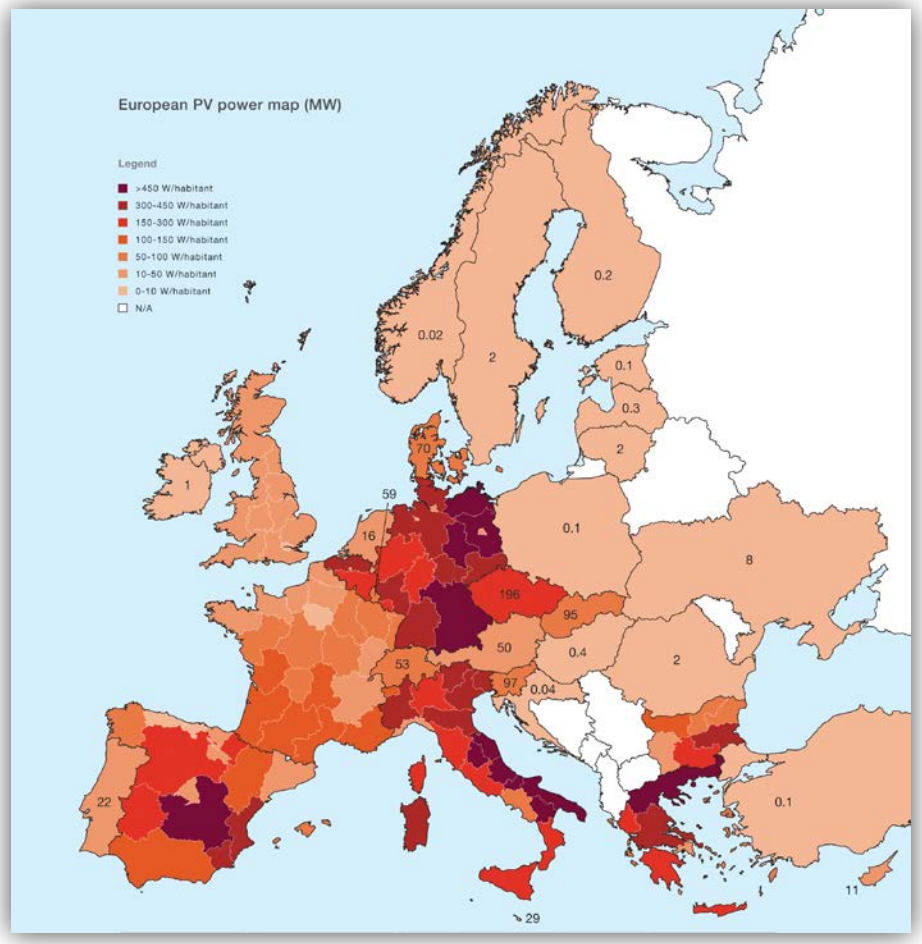
Net generation capacity added in the EU 27 2000-2012 (GW)



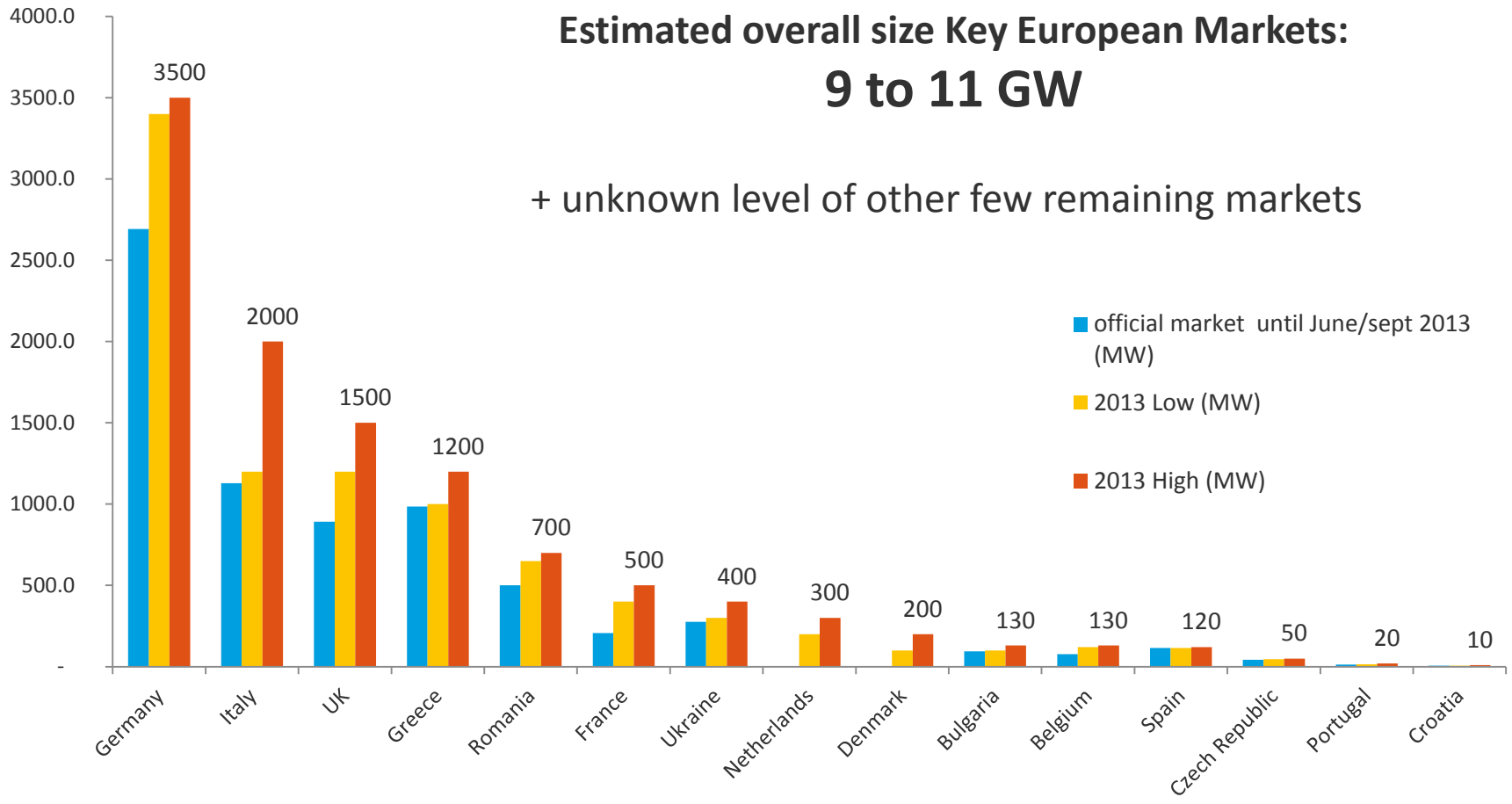
European PV market segmentation in 2012 (%)



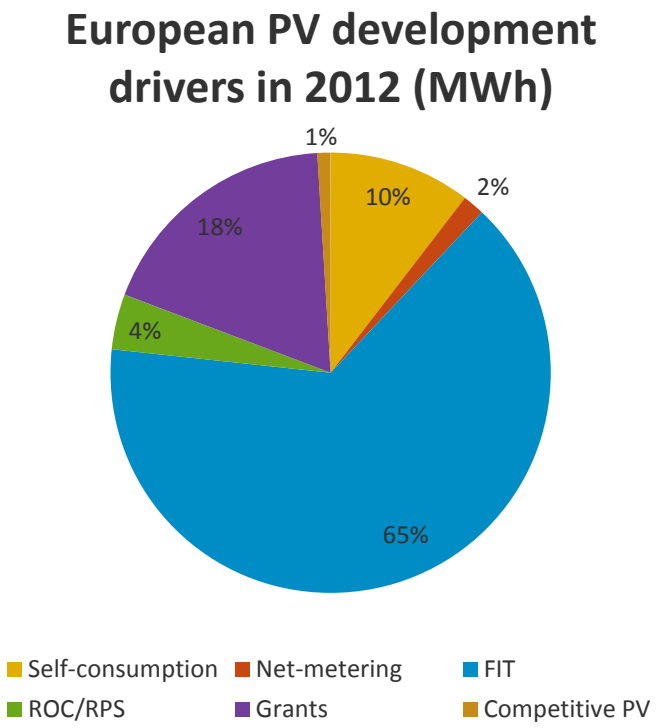
Source: EPIA, "Global Market Outlook for Photovoltaics 2013-2017", 2013



Europe main markets in 2013

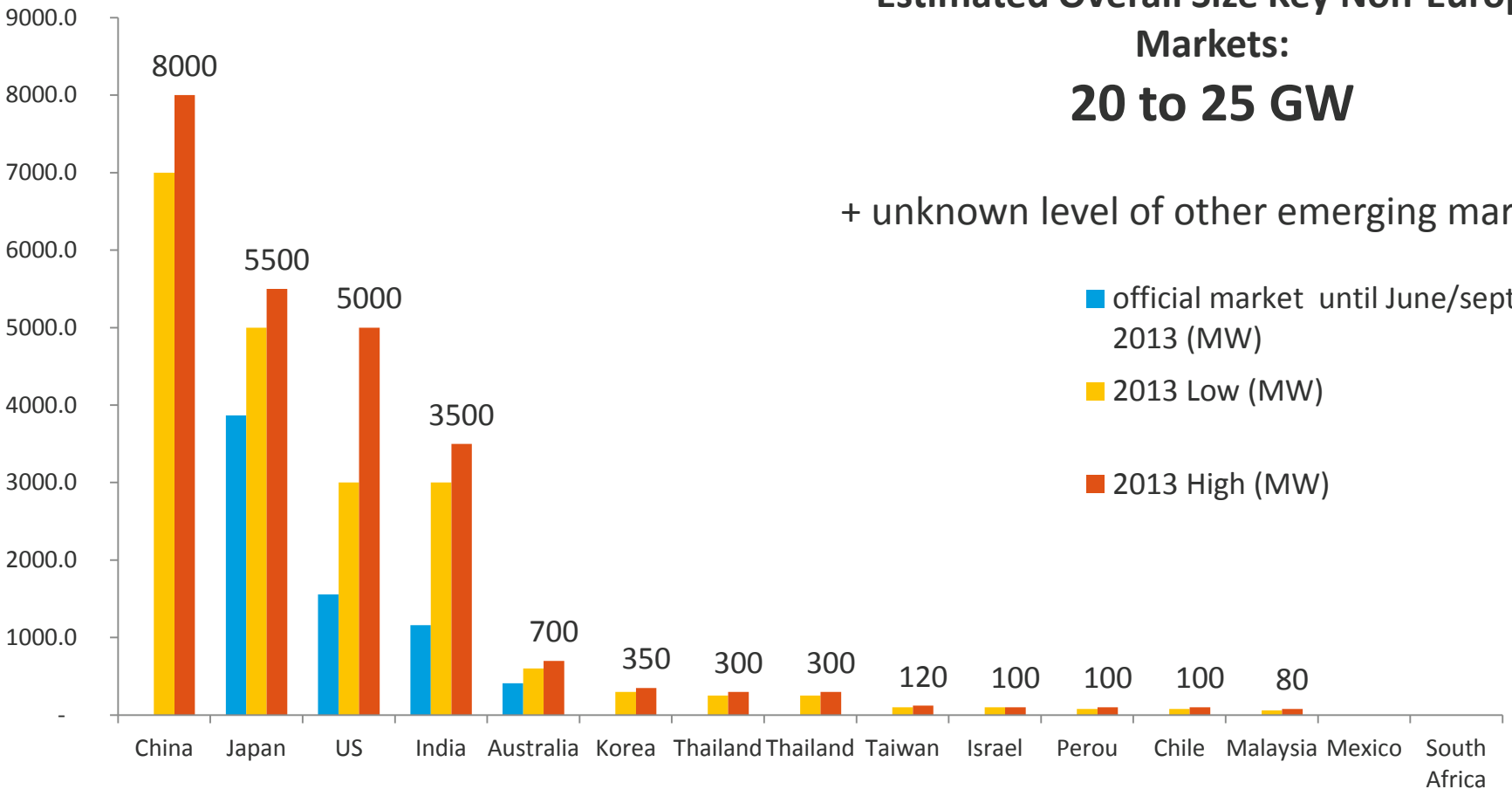


Market trends for next years…



- Most likely to stabilise in Key markets
  - → No other EU markets likely to take it over
- Self-consumption, the new main driver
  - → Future of electricity tariffs will be crucial !
- Trend to integrate PV in the Emarket
  - → Redesign is needed
- Very large systems do not have a (short ?) future in Europe anymore

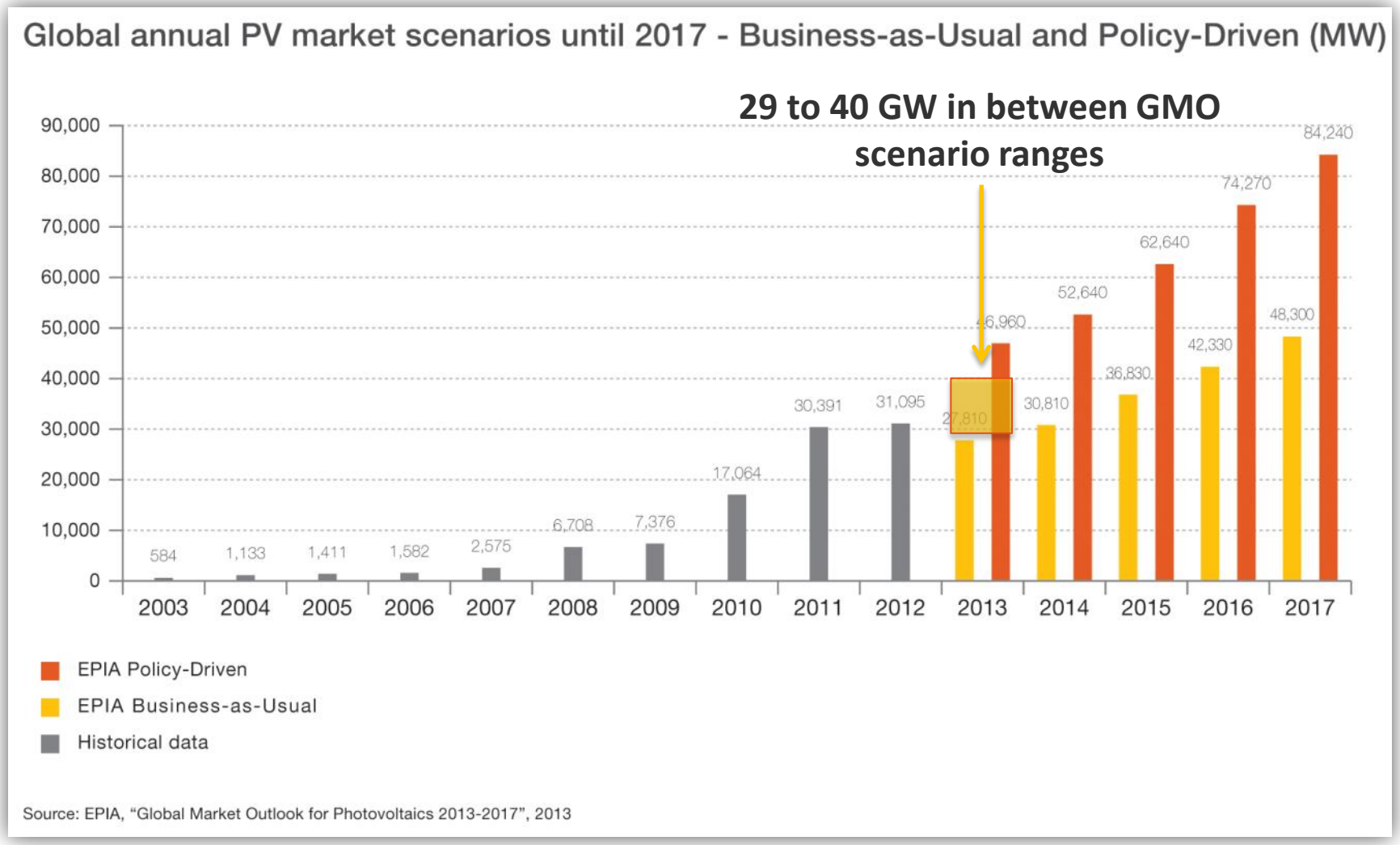
Non- European Markets in 2013



Estimated Overall Size Key Non-Europe Markets:

20 to 25 GW

+ unknown level of other emerging markets


Global annual PV market scenarios until 2017 - Business-as-Usual and Policy-Driven (MW)
29 to 40 GW in between GMO scenario ranges
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
584
1,133
1,411
1,582
2,575
6,708
7,376
17,064
30,391
31,095
27,810
46,960
30,810
52,640
36,830
62,640
42,330
74,270
48,300
84,240
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
EPIA Policy-Driven
EPIA Business-as-Usual
Historical data
Source: EPIA, "Global Market Outlook for Photovoltaics 2013-2017", 2013

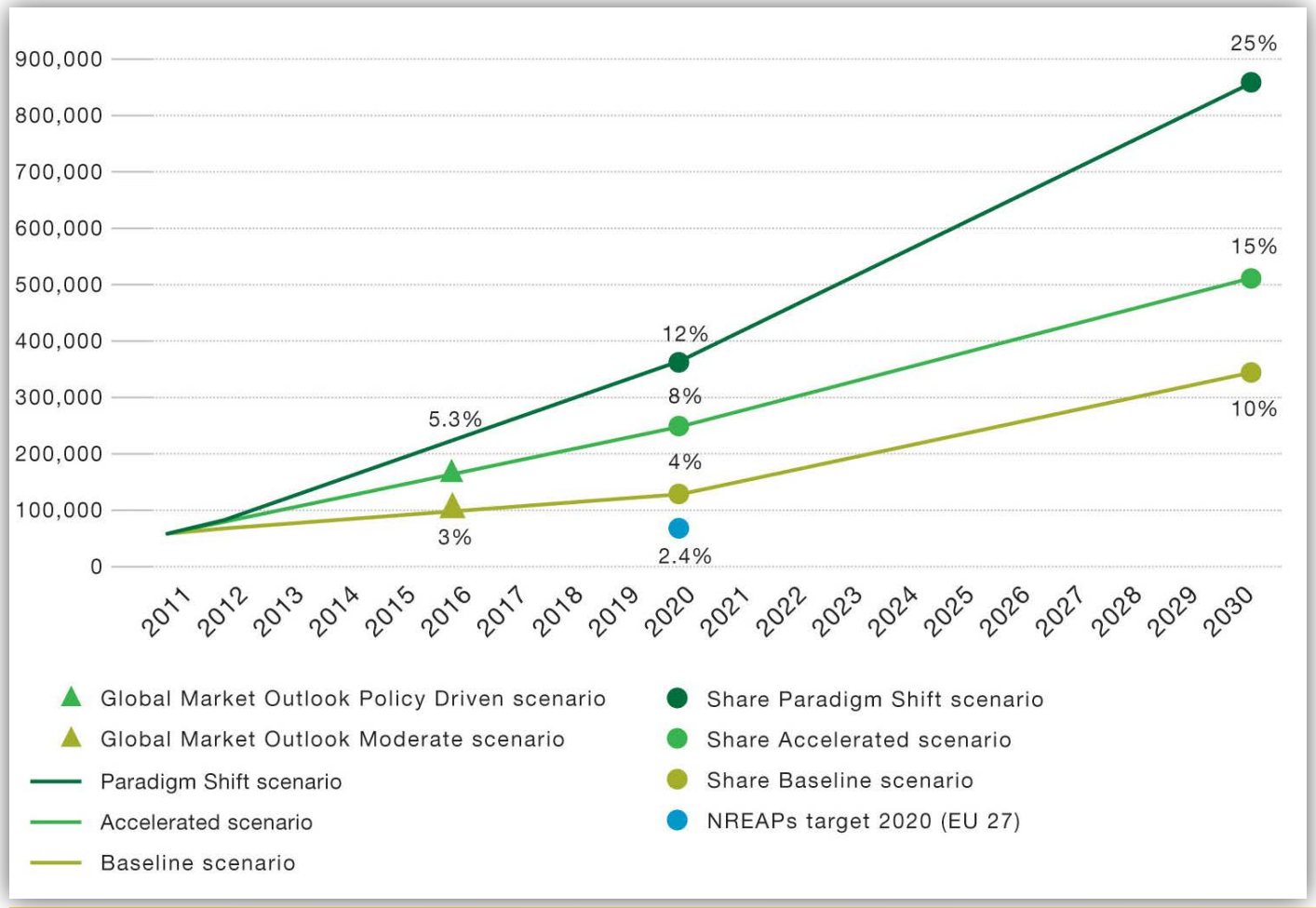
Part

03

On the road to high PV penetration

"You and I come by road or rail, but economists travel on infrastructure"
Margaret Thatcher

EPIA's visions for 2020 and 2030 in EU (MW)



Challenges, solutions and collaborations

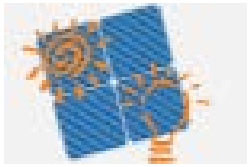
REserviceS
ECONOMIC GRID SUPPORT FROM VARIABLE RENEWABLES

metaPV

GRID4EU
INNOVATION FOR ENERGY NETWORKS

iGREENGrid

EPIA
European Photovoltaic Industry Association



IEA PVPS Task 14

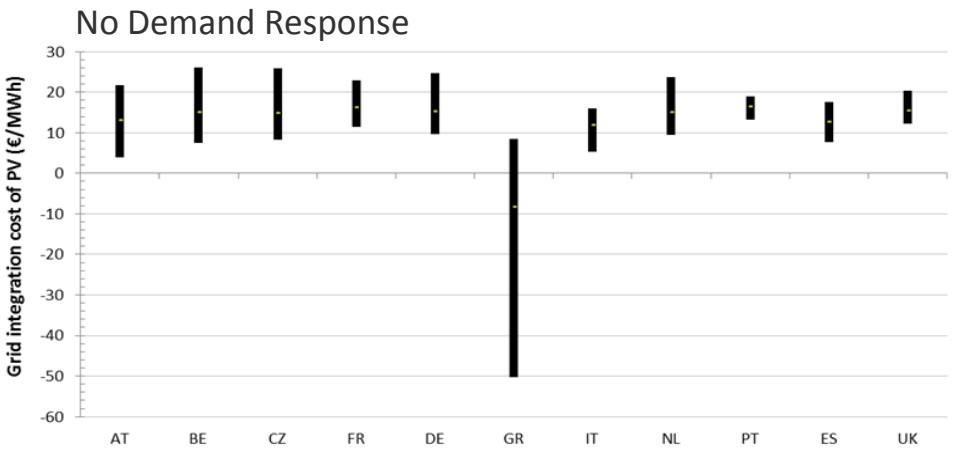
PVPARITY

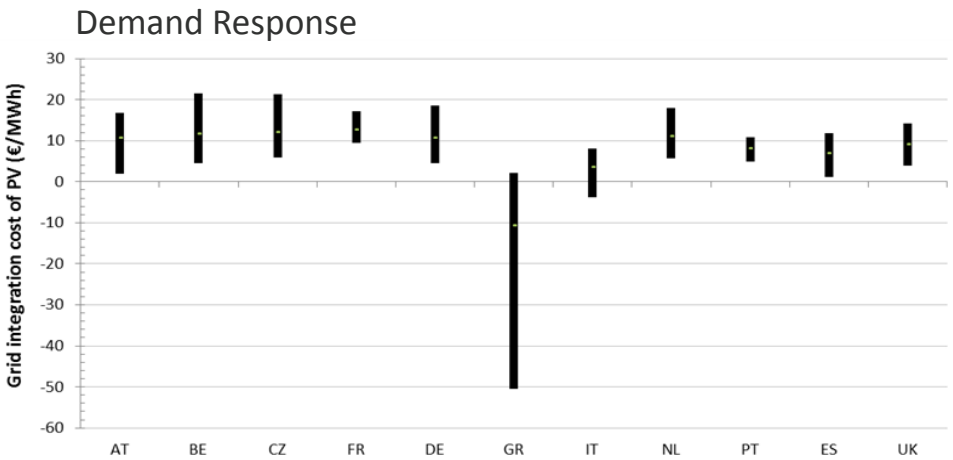
iea International Energy Agency
GIVAR III

HIGHWAY 2050

PV GRID
Make it smart!

Mapping the challenges: PV integration Costs





Source: Imperial College of London, 2013

- From 2% to 15 % penetration level
  - → 2012 to 2030
- Worst case scenario
  - → No modification of the current practices
- But cost below €26/MWh in 2030
  - → 20% savings with DR
  - → Depends on the correlation between peaks
- Order of magnitude:
  1. Generation Adequacy
  2. Distribution grid costs
  3. Transmission grid costs
  4. Balancing costs

Part

04

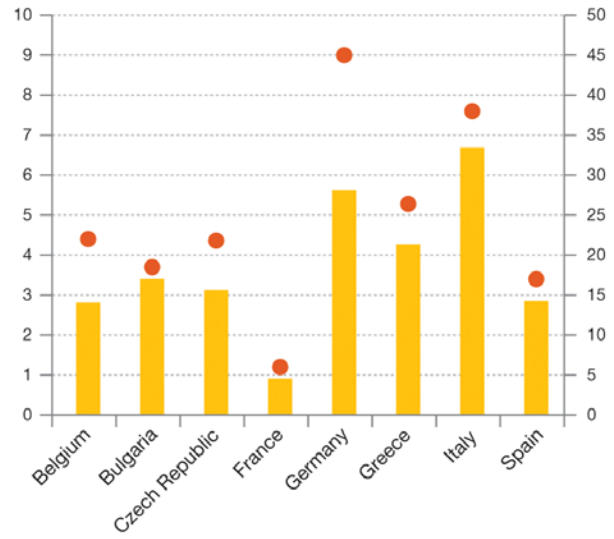
Transmission level

"Size does matter"
Godzilla

Pay attention to instantaneous power

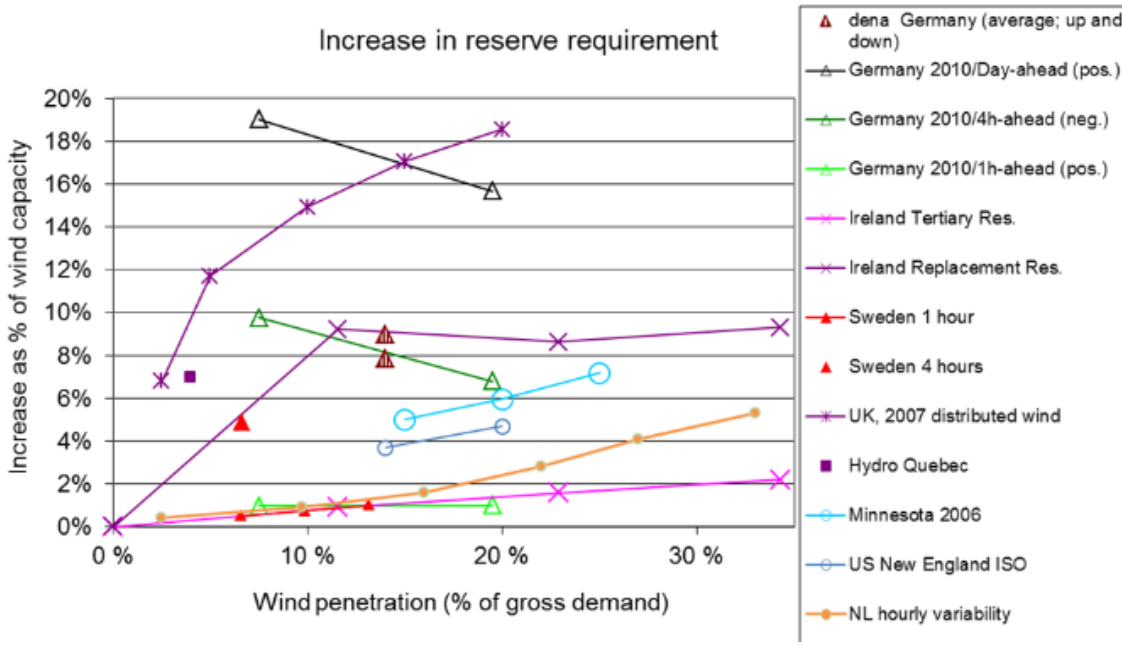
REserviceS
ECONOMIC GRID SUPPORT FROM VARIABLE RENEWABLES

Annual average and maximum instantaneous PV contribution to electricity consumption in 2012 (%)



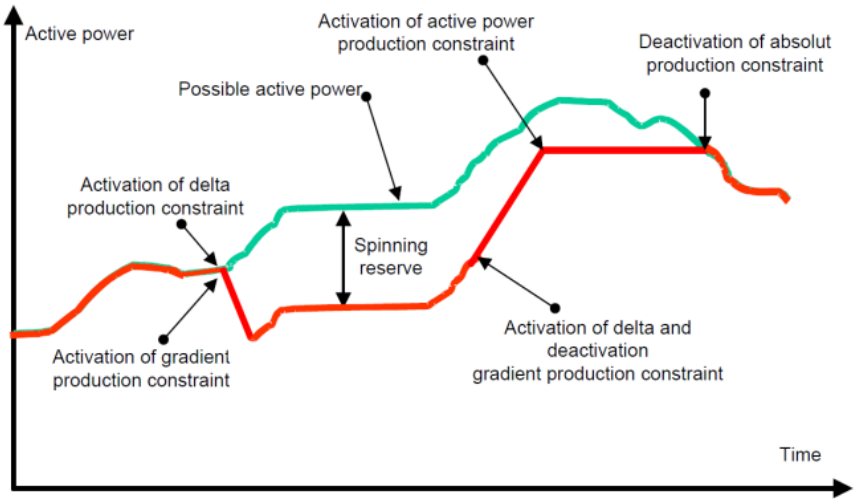
PV average contribution to electricity consumption in 2012 (left axis)

PV maximum instantaneous contribution to electricity consumption in 2012 (right axis)



Source: Eirgrid and Soni, 2010 and IEA WIND Task 25, 2011

Ancillary services provision: functionalities

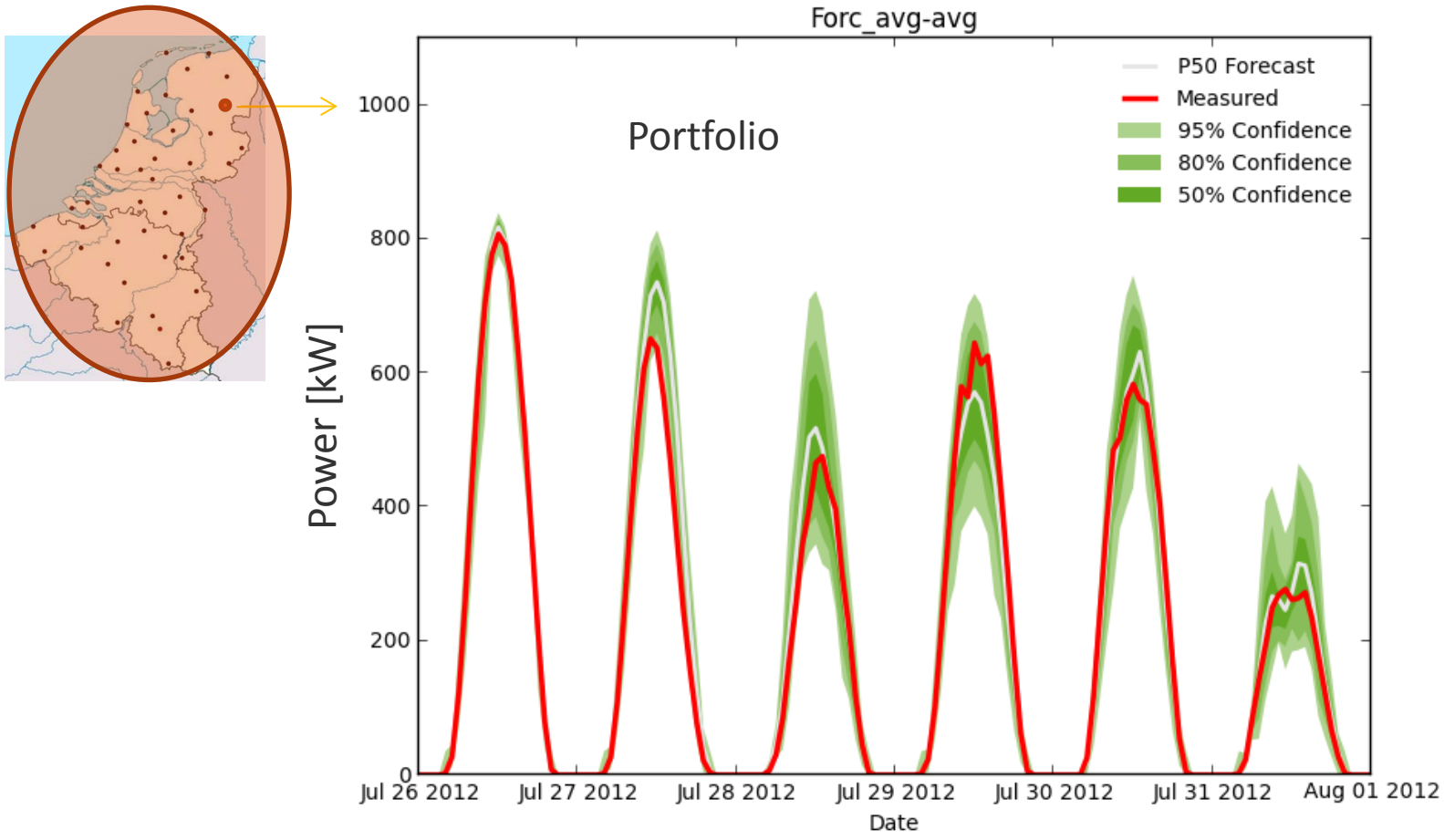


Source: Eneginet.dk, 2010

Type of functionality	Functionality name	FCR	FRR	RR	FFR	RM
Technical	Active Power Control	X	X	X		X
	Active Power Delta Control Mode	X	X	X		
	Active Power Limitation Control Mode	X	X	X		X
	Active Power Gradient Control Mode	X	X	X		X
	Frequency Sensing	X	X		X	
	Frequency Sensitivity Mode (or Droop Control)	X	X			
	Active Power Setpoint Processing	X	X	X	X	X
	Setpoint Priority Management	X	X	X	X	X
	Temporary Active Power Increase				X	
Operational	Ability to Calculate Actual Active Power Production	X	X			
	Power production forecast		X	X		X
	Communication and Control Interface	X	X	X	X	X
	Communication and Control Interface with the SO	X	X	X	X	X

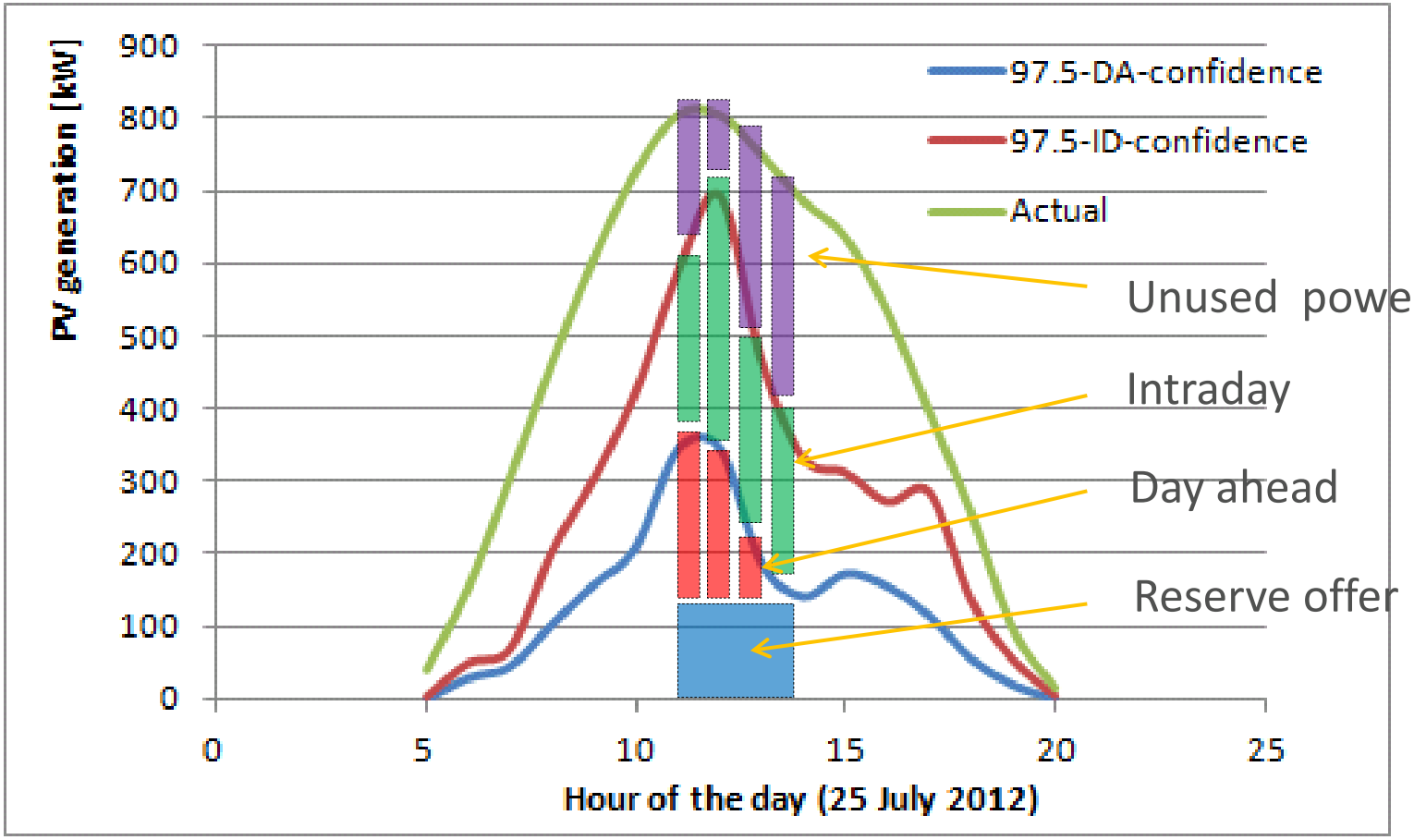
Type of functionality	Functionality name	SSVC	FRCI
Technical	Reactive Power Setpoint Processing	X	
	Reactive Power Control Scheme	X	
	Reactive Power Control	X	
	Voltage Control	X	
	Power Factor Control	X	
	Reactive Power Provision	X	
	Fast Possitive Sequence Reactive Current Injection Capability		X
	Fast Active Current Reduction Capability		X
	Fast Negative Sequence Current Provision		X

Moving the discussion to the portfolio level



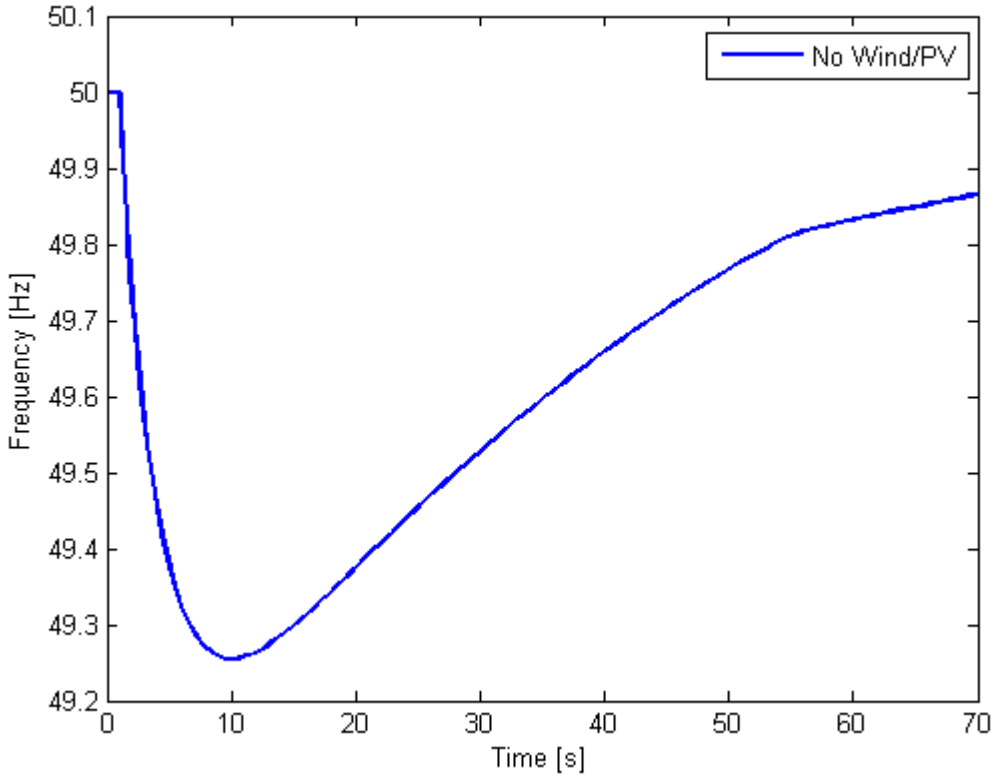
Source: 3E, 2013

Reserve provision by PV portfolios



Source: 3E, 2013

Iberia study case



- WILMAR Unit Commitment and dispatch model
- Iberian system modeled on a unit basis
- High instantenous wind and PV
  → 28.5 % wind and 13.7 % PV
- Analysis of a 1 GW unit trip

No Wind/PV

Thermal: 237 MW
Hydro: 802.5 MW

Limited Wind 1s and PV 0.5s

Wind: 300 MW
PV: 300 MW
Thermal: 67.8 MW

Source: VTT, 2013

Part

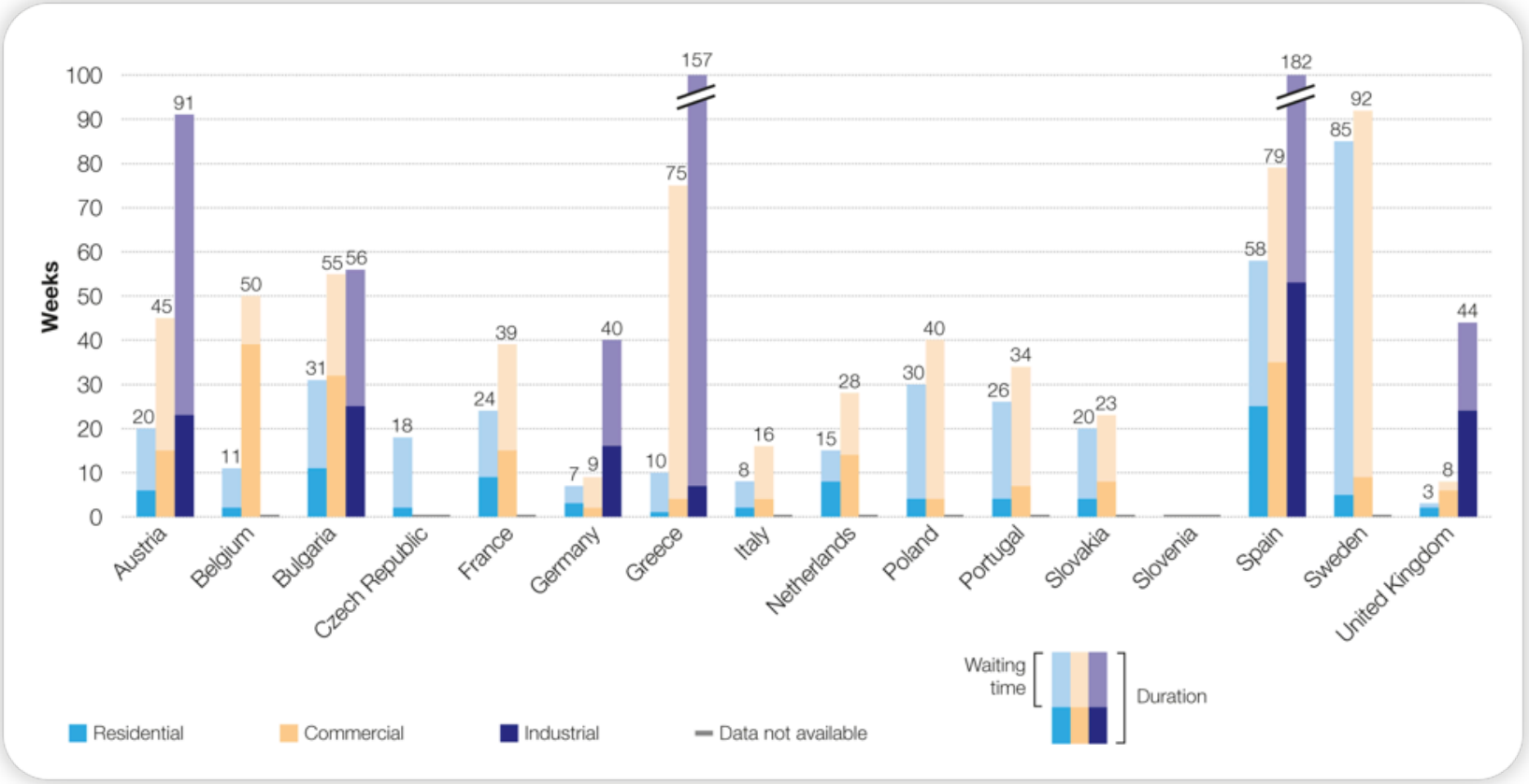
05

Distribution level

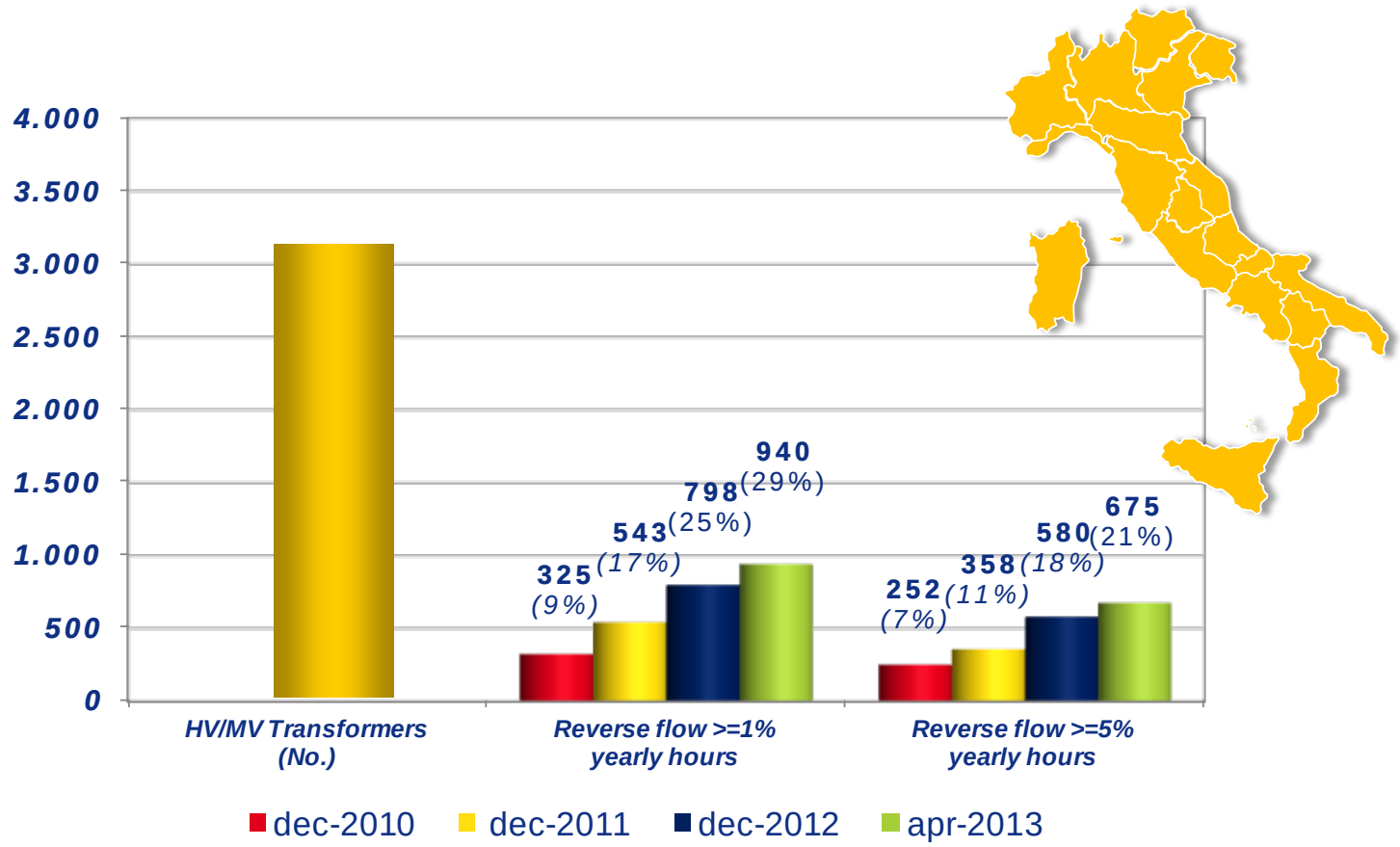
"Small is beautifull"
Leopold Kohr - Economist and philosophical anarchist

You are not alone (Time is money)

PV GRID
Make it smart!

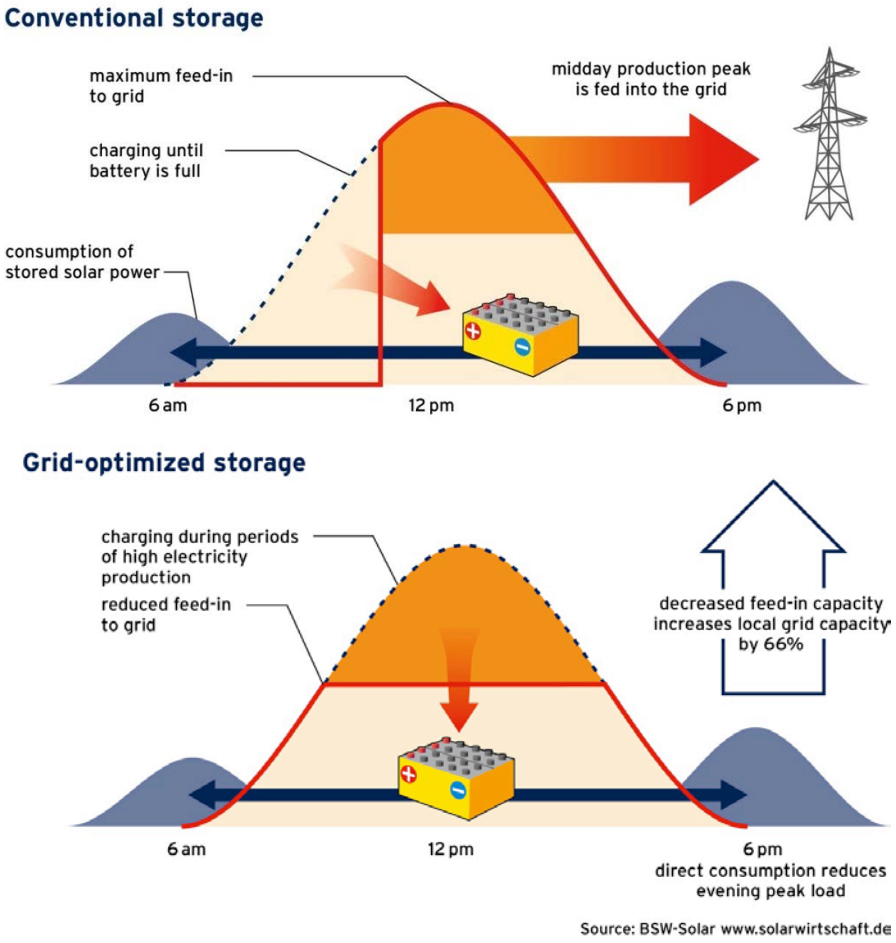


~~Distribution~~ Collection grids



Source: Enel Distribuzione, 2013

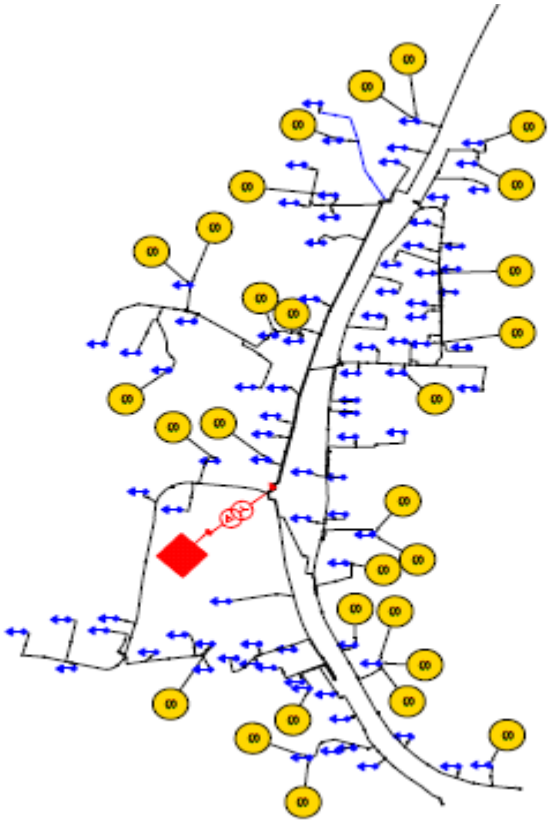
German PV-Storage program



- Study of BSW / Fraunhofer ISE:
  - → Power peaks can be reduced by 40% without curtailment
  - → Increase of up to 66% of the hosting capacity
- Requirements and technical prerequisites to be financed:
  - → Grid supporting operation
  - → new PV system or retrofit to solar PV system
  - → PV system cap of 30 kWp
  - → Effective power reduction to 60%
- 8000 systems financed in 2013

Source: BSW, 2013

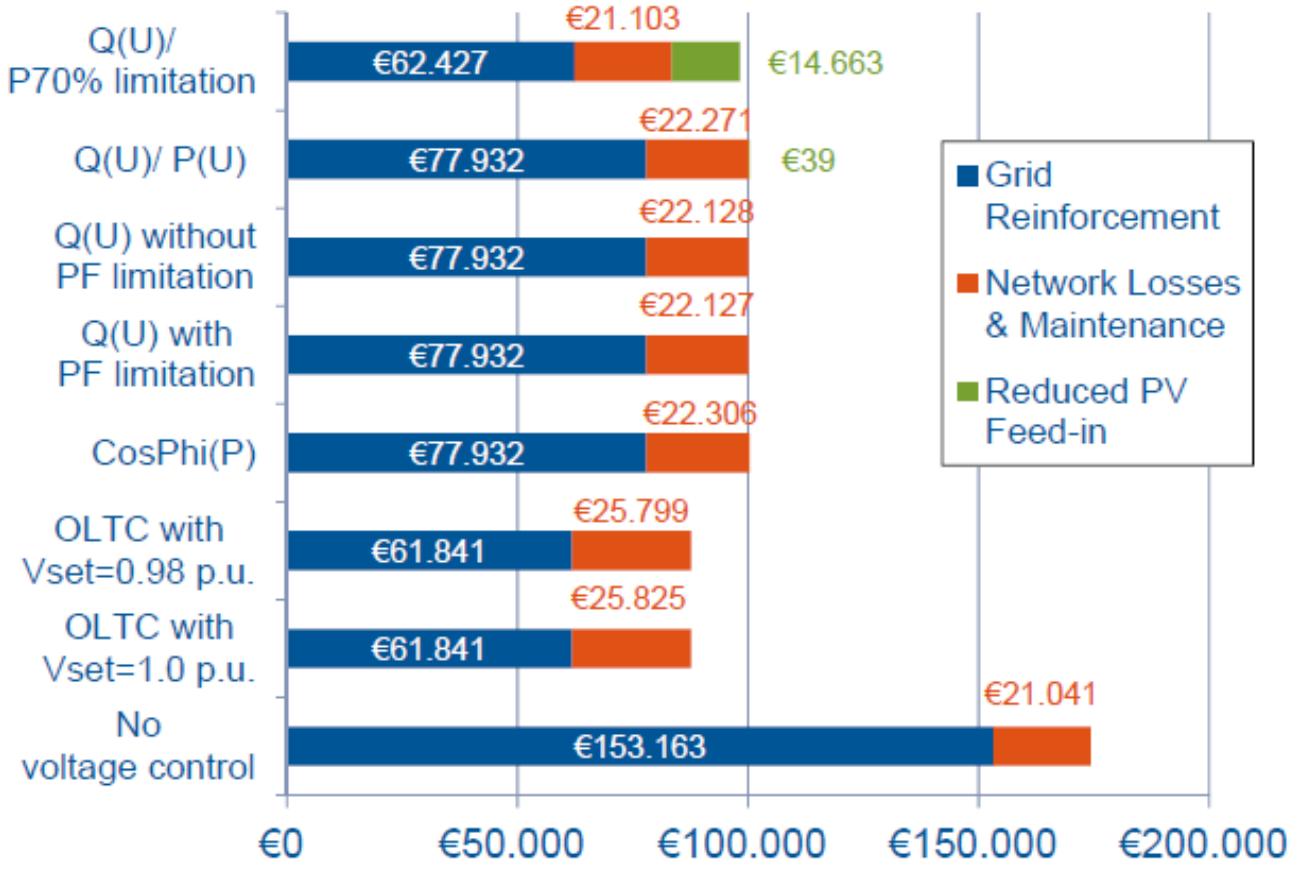
Voltage control in LV grids



- Real LV grid in Bavaria (0.4kV /3-phase)
- Feeder configuration: radial
- Installed DER capacity: 417 kW (100% PV)
- Residential households: 88
- PV penetration (Installed PV capacity over peak load): 3.6
- MV/LV transformer: 0.4 MVA (no OLTC installed)

Courtesy of Bayernwerk, 2013

Doubling the hosting capacity ?



Source: Fraunhofer IWES, 2013

From the simulations to the real world...

Effectiveness of solutions	Technical solution	CZ	DE	ES	IT
HIGH EFFECTIVENESS	Curtailment of power feed-in at PCC				
	Network Reinforcement				
	Reactive power control by PV inverter Q(U) Q(P)				
	Active power control by PV inverter P(U)				
	Prosumer storage				
	On Load Tap Changer for MV/LV transformer				
NORMAL EFFECTIVENESS	SCADA + direct load control				
	Network Reconfiguration				
	Self-consumption by tariff incentives				
	Wide area voltage control				
	Static VAr Control				
	Booster Transformer				
	SCADA + PV inverter control (Q and P)				
	DSO storage				

- Rules forbidding **RES energy curtailment** except for security issues
- Insufficient DSO access to **advanced PV capabilities**
- Insufficient Framework for **DSO Storage**
- Regulatory frameworks that do not **incentivize "Smart Grid"**

Part

06

Conclusions

"Don't worry about the world coming to an end today. It is already tomorrow in Australia."
Charles M. Schulz - American cartoonist

High PV penetration: how to get there ?

More an economical/regulatory question rathe than a techical one

- *PV integration is entirely feasible, but adjustments are needed*

There is a need to define the role and responsibilities of each actors

- *A 4 variables optimisation : Markets VS DSOs Vs TSOs Vs PV owners*

New focus on the distribution level

- *Need for aggregation*
- *Need for new metering and communication strategies*
- *Standardisation of components and protocols is a must !*

Empowering the consumer/prosumer

- *New business models for PV*
- *Development of re(al)tail markets*

THANK YOUR FOR YOUR ATTENTION

You can download this presentation on : http://www.iea-pvps.org/

This document was presented by

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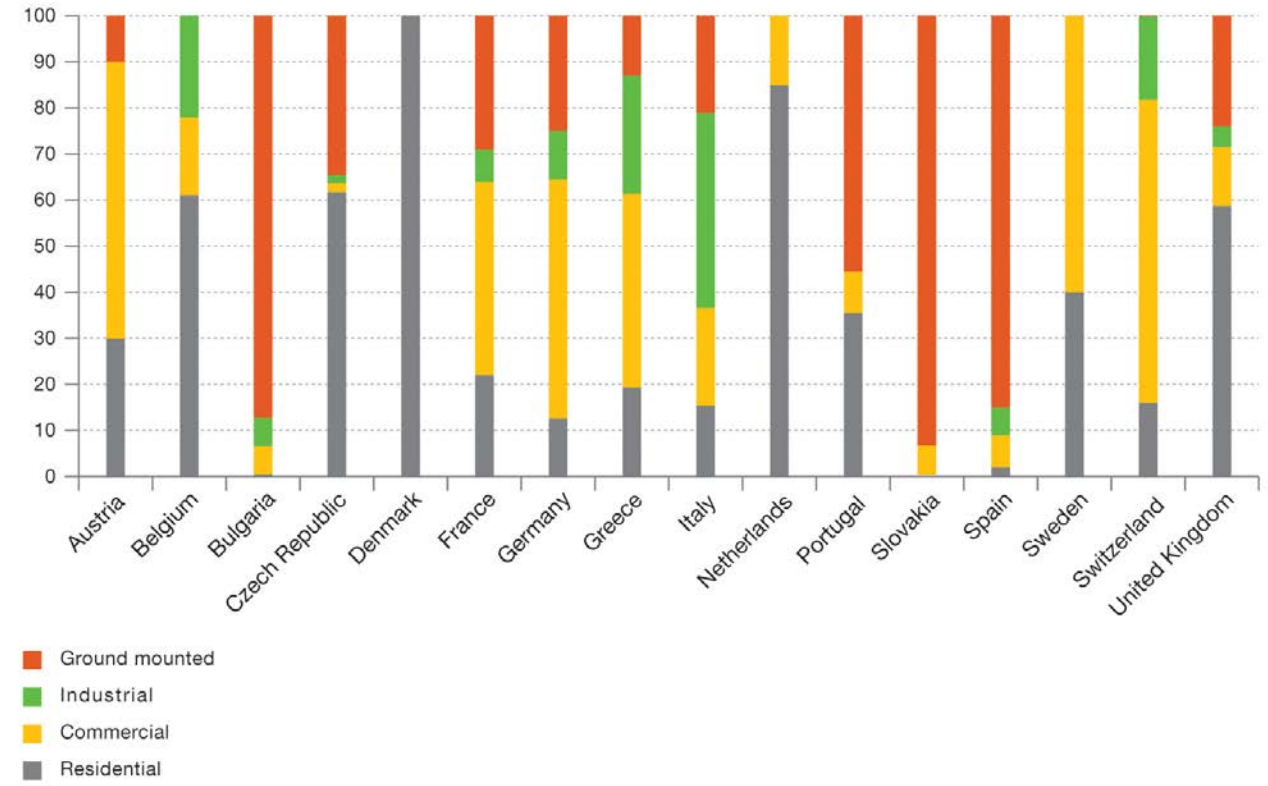
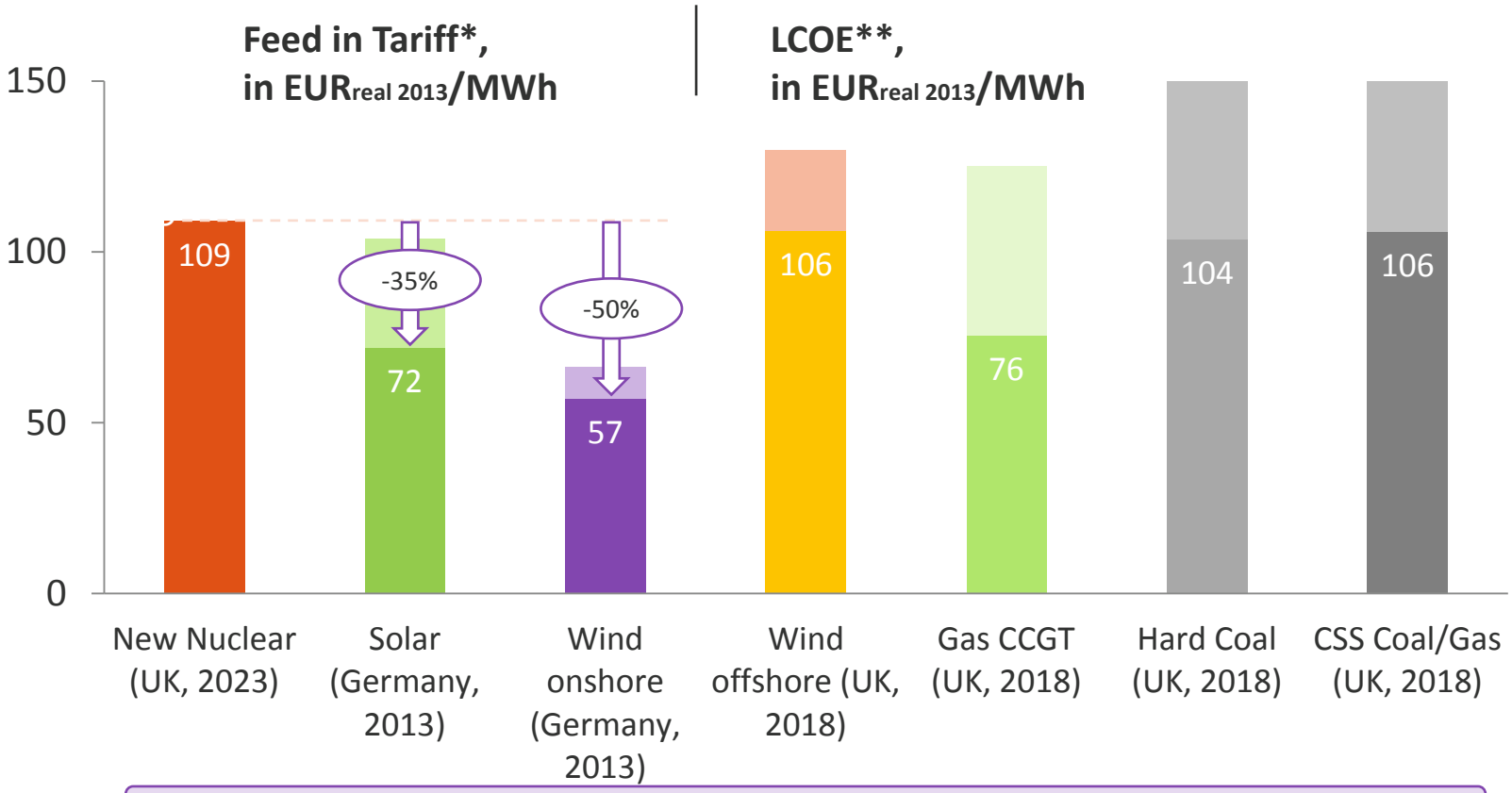
Market segmentation in Europe

European PV cumulative capacity segmentation by country in 2012 (%)



Source: EPIA, "Global Market Outlook for Photovoltaics 2013-2017", 2013

New Wind and PV are competitive



A combination of Wind onshore + Solar + Gas would cost ~70 EUR/MWh